the skin, by .121 of a second; that two points were touching, by .194 of a second. The time necessary for uniting three letters was shortened by 1.956 seconds in 500 repetitions. In associating abstract words, there was a difference of nearly five seconds between the longest and the shortest time.[1]

MINERAL PHYSIOLOGY AND PHYSIOGRAPHY.

THIS book is a collection of essays which their author has published during the past few years in the proceedings of several learned societies, especially in the Transactions of the Royal society of Canada. The preface states that they were all written with a predetermined plan, which their presentation in this connected form for the first time fully realizes. The work will furnish a valuable addition to every geological library. There is apparent in it an astonishing amount of learning and painstaking research, in spite of the fact that the views of others are not infrequently presented in a partial or one-sided manner; the author's conclusions also are well worthy of study, although many of them will hardly be received by geologists as final.

It would be impossible, in a brief review, to do justice to a single one of the essays, to say nothing of the collection of them before us. The first two serve as a general introduction and attempt to show the relations of the natural sciences to each other and to geology. Then are considered in succession the chemistry of the earth's atmosphere; the origin and decay of the crystalline rocks; a natural system in mineralogy; a history of pre-Cambrian rocks and serpentines; and, finally, the Taconic question.

The most interesting and novel portion of the work is contained in chapters v. and vi., which set forth the author's remarkable views regarding the origin of the crystalline schists. These, as he states, are purely Neptunic or Wernerian. The former hypotheses relating to the Archean rocks are reviewed and classified as, 1°, endoplutonic; 2°, exoplutonic; 3°, metamorphic; 4°, metasomatic; 5°, chaotic; 6°, thermochaotic. None of these are regarded as satisfactory; and a seventh, so-called 'crenitic' theory is therefore advanced. According to this, the globe has solidified regularly from its centre outward, its last layer being a basic, quartzless rock, not unlike dolerite in composition. This mass was fissured and rendered porous by 'refrigeration and crystallization' (!) and upon it were precipitated the waters, till then held in the atmosphere. These were set in circulation by the heat from below, and under high temperature and pressure they leached out the more acid, alkaline silicates from the basic substratum below, and deposited them in thick layers at the surface, like the products of thermal springs (hence the term 'crenitic,' from κρήνη, 'a fountain'). The chemistry of this process is supposed to resemble that whereby quartz, orthoclase, and the zeolitic minerals are occasionally deposited in cavities of basic eruptive rocks. By such crenitic action, in the author's opinion, all the banded, pre-Cambrian rocks were formed. These were, moreover, of such a thickness as to bury the original basic substratum too deeply for any subsequent upheavals to expose it at the earth's surface. The crenitic hypothesis is also supposed to offer "for the first time a reasonable and tenable explanation of the universal corrugation of the oldest crystalline strata," in the removal of such a large quantity of matter from the underlying basic layer. Through these crumpled crenitic rocks (Archean granites, gneisses, and schists) came intrusions of a basic magma derived from the underlying or original stratum, while the upper or transition pre-Cambrian rocks, as the author calls them with Werner, are regarded as derived from the subaerial decay of the two types of primary origin.

The objections which at once suggest themselves to this remarkable theory of the origin of the crystalline rocks are far too many to be even mentioned here. The leaching-out of a layer, 'at least many miles in thickness,' of quartz and potash-felspar, from a basic substratum, requires sufficient draughts on the imagination; while, even in case this be assumed as possible, it is still more difficult to conceive how the waters could circulate through this compact overlying layer which they were depositing, with sufficient freedom to increase it to anywhere near the thickness which the hypothesis requires.

No one will deny that any single *one* of the numerous theories hitherto proposed, fails to satisfactorily account for all the phenomena exhibited by the so-called crystalline rocks; nor is it at all probable that any theory ever will accomplish this. There is doubtless some element of truth in all the theories, and the only way to explain the diversity of Archean geology would seem to be by the assumption of an equal diversity in the causes which produced it. The dogma that many different agencies may not have acted at the same time in the formation of the pre-Cambrian rocks, is as dangerous as the other, that the same agency may

[1] It is not quite clear whether these differences refer to the extreme limits of a single experiment, or to the extreme differences of the average of each set of fifty observations.

Mineral physiology and physiography. By T. STERRY HUNT. Boston, Cassino. 8°.

not have acted at different times, — one that carries with it the fallacious conclusion that the lithological character of a rock is any reliable indication of its geological age.

Chapter viii., entitled 'A natural system in mineralogy,' suggests a new basis of mineralogical classification, and illustrates it in a new classification of the silicates. These are divided into three main groups, according as their bases are in the protoxide state (protosilicates), in both the protoxide and sesquioxide states (protopersilicates), or wholly in the sesquioxide state (persilicates). These groups are further divided into various tribes according to principles which cannot be explained in this place. Whatever may be the chemical merits of this system, it would appear to do serious violence to the crystallographic relationships of certain minerals, as may be seen in the wide separation of the members of the pyroxene and amphibole groups.

The three remaining essays are of an historical character, and contain a vast amount of information regarding the views which have been held on the subject of crystalline rocks. The first of these is a summary of the writer's report E of the Second geological survey of Pennsylvania, on the pre-Cambrian rocks in America and Europe. The second deals with the geological history of the serpentines, and develops the writer's idea that all serpentines are of aqueous origin, being of the nature of chemical precipitates. The chemical origin of a small and long-since buried bed of a serpentine-like deposit occurring in the Onondaga salt-group at Syracuse, N.Y., and of the magnesian silicates (sepiolites) of the Paris basin, together with certain reactions which are found to take place between the carbonates of lime and magnesia and free silica in heated solutions, are adduced as a proof that *all* serpentine is of chemical origin. There seems here to be a very partial and one-sided statement of the best authorities on this subject, for the origin of serpentine by the hydration of eruptive chrysolitic rocks will surely be disputed to-day by no one who has carefully and impartially looked into the matter. Though there may be truth in both hypotheses, there is more evidence in favor of the latter; so that here, again, the danger of accounting for all rocks of similar character by one set of causes becomes apparent.

The final essay is devoted to an elaborate review of the Taconic question and a statement of the writer's opinion that the Taconic of Emmons is a formation of the transition class, which unconformably underlies the Cambrian, and is separated from it by a great interval of time which includes the Keweenian period.

Throughout, the book is interesting, — almost fascinating, — but nevertheless full of danger to any one who accepts it implicitly as a guide, or to the beginner who is not able to estimate it in comparison with the work of others.

REMSEN'S ELEMENTS OF CHEMISTRY.

IN the preface to his 'Elements of chemistry,' Professor Remsen states his opinion, that if a course in chemistry "does not to some extent help the pupil to think as well as to see, to reason as well as to observe, it does not deserve to be called rational." An essential part of his plan in this elementary course is the performance of experiments by the pupil, who is then to be questioned by the teacher concerning the results of the experiments, and the conclusions to be drawn from them. Appropriate questions are given in the book in connection with the description of each experiment, and a quite extensive list of questions and problems (not numerical) is appended at the end of the work. A number of experiments, with questions, illustrative of chemical change in general, are given at the outset, before even the names of the elements, or the distinction between elements and compounds, is imparted. The atomic theory and that of valence are treated briefly and clearly, special care being taken to prevent the too common confusion of facts and hypotheses in the young student's mind. A great deal of attention is devoted to subjects which are likely to interest the pupil by reason of their practical importance or their relation to his daily life. Such are the manufacture of soap and paper, fermentation, bread-making, the working of iron, and the impurities of water. In these as well as in other subjects the endeavor seems to have been made to introduce all of the most recent discoveries and advances which are suitable to an elementary treatise. Examples are the water-gas process, the liquefaction of the 'permanent' gases, the electrical furnace, celluloid, cocaine, and artificial alizarin.

About one-ninth of the volume is devoted to a description of some of the compounds of carbon. The relations between the principal classes of these bodies are pointed out, but no attempt is made to teach the structural formulae of the more complex compounds.

THE U.S. consul at Palermo, Mr. Philip Carroll, has forwarded to the state department a translation of a pamphlet issued by Prof. E. Albanese, president of the sanitary council of

The elements of chemistry. By IRA REMSEN. New York, Holt. 12°.